U. S. Department of Agriculture
Forest Service Research Paper SO-54

1970

Hydrologic Effects of Prescribed Burning and Deadening Upland Hardwoods in Northern Mississippi

S. J. Ursic

Southern Forest Experiment Station
Forest Service
U. S. Department of Agriculture

This publication reports research involving pesticides. It does not contain recommendations for their use, nor does it imply that the uses discussed here have been registered. All uses of pesticides must be registered by appropriate State and/or Federal agencies before they can be recommended.

CAUTION: Pesticides can be injurious to humans, domestic animals, desirable plants, and fish or other wildlife—if they are not handled or applied properly. Use all pesticides selectively and carefully. Follow recommended practices for the disposal of surplus pesticides and pesticide containers.

PROTECT

Use Pesticides Safely

FOLLOW THE LABEL

U.S. DEPARTMENT OF AGRICULTURE

Hydrologic Effects of Prescribed Burning and Deadening Upland Hardwoods in Northern Mississippi

S. J. Ursic[1]

In the South, many unproductive stands of upland hardwoods are being converted to pine. Direct seeding, which is cheaper than planting, generally requires the baring of mineral soil. Fire is the most practical way of preparing seedbeds, but land managers are increasingly apprehensive about burning where the potential for increasing erosion and surface runoff is high. This paper reports the 3-year effects of a single prescribed burn plus deadening of hardwoods on two small watersheds in northern Mississippi, where soils are extremely erosive.

Rainfall, runoff, and sediment were recorded on three small watersheds from 1958 through 1963. Two watersheds were then burned, the hardwoods on them were deadened, and loblolly pines were planted. The third watershed was maintained as the untreated control. Relationship between each treated watershed and the control were established from the pretreatment records. These relationships served as a base for evaluating hydrologic behavior of the watersheds after treatment. The composition and distribution of materials on the forest floor were also determined before and after treatment.

The long-term objective of the study is to determine the hydrologic effects of converting from hardwoods to loblolly pine. The effects of burning and hardwood deadening reported here could be isolated because the treatment increased stormflow volumes, and any decreases caused by the pines were negligible during the first 3 years after planting.

[1] Principal Hydrologist at the Forest Hydrology Laboratory, Oxford, Miss. The Laboratory is maintained by the Southern Forest Experiment Station in cooperation with the University of Mississippi. The study was installed with the cooperation of the Soil Conservation Service.

STUDY WATERSHEDS

The study area is on the Upper Coastal Plain in northern Mississippi. The mean annual precipitation of 53.3 inches is fairly well distributed throughout the year. Mean daily temperature is 63.1° F. Average dates of the first and last frosts are November 7 and March 28; thus, length of the frost-free season averages 224 days.

All three watersheds have a history of grazing and burning abuse and have suffered sheet erosion, but no gullies are present. Slopes range up to 10 percent on ridges and up to 45 percent on the hillsides.

Northern Mississippi is underlain by deep unconsolidated strata of sands and clays. Upland soils are typically sandy, but the study area is on the eastern fringe of a loessial blanket. Loess commonly occupies the ridges and upper slopes. Watershed I has Loring silt loam and Providence silt loam (loess) soils on the upper slopes, which cover 65 percent of the 2.56-acre drainage, and Ruston sandy loam on lower slopes, which cover the rest of the area. It has a 49-foot range in elevation from the watershed divide to the measuring flume.

Watershed II has Providence silt loam on the upper slopes, which make up 34 percent of the drainage, and Ruston sandy loam on the remainder, the lower slopes. It covers 2.12 acres and has a 58-foot range in elevation.

Watershed III is all Providence silt loam. It drains 2.13 acres and has a 44-foot range in elevation.

The untreated watershed was selected on the basis of soils. Watershed III with all silt loam (loess) soils and Watershed II with two-thirds of its area covered by sandy loam were treated identically. Watershed I, intermediate with respect to soils, served as the common control.

Before treatment the tree cover consisted largely of post oak (*Quercus stellata* Wangenh.), hickories (*Carya* spp.), and blackjack oak (*Quercus marilandica* Muenchh.). The stands, which were completely inventoried, contained an average of 215 trees per acre larger than 0.5 inch d.b.h.; half the trees were cull. Basal area per acre averaged 52 square feet, 23 square feet of which were cull (table 1). Merchantable volume was about 570 board feet per acre.

Litter and Herbaceous Vegetation

Watersheds were divided into ¼ acre hexagonal blocks. The distribution of ground cover was determined from two permanent 1-chain transects selected at random bearings from the center of seven blocks on each watershed. A 1-chain tape was stretched tightly along each transect and the cover under each link recorded.

Litter and fermentation layers were sampled separately on two 0.96-square-foot plots at random distances along each transect. There were 28 samples per watershed. Residual amounts of the F layer, after drying and screening, were determined by loss on ignition. Grasses and herbaceous material were clipped 1 inch above the groundline on enlargements (4.8 square feet) of the litter plots.

The forest floor on the three watersheds averaged 0.75 inch in depth. The depth of the A_1 soil horizon averaged 0.81 inch. The 0- to 2-inch soil layer had an average bulk density of 1.07 g. per cc. and contained 3.84 percent organic matter by weight. The amount of bare soil exposed averaged 1 percent.

METHODS

Watershed Treatment

Watersheds II and III were burned with a slow backfire on December 19, 1963 (fig. 1). To determine their long-term effects, 1-0 loblolly pine seedlings were planted on the two burned watersheds on March 12, 1964. The seedlings were planted with dibbles at a 6- by 6-foot spacing. It is assumed that the planting operation and the development of the pines through 1966 had little hydrologic effect. The watersheds were planted rather than seeded to help ensure a uniform stand.

The overstory on the two burned watersheds was treated on May 13-14, 1964. Undiluted 2,4-D amine was injected into the bases of all stems 1 inch in diameter and larger. The remaining stems were cut and the stumps mopped with a mixture of 2,4-D and 2,4,5-T in diesel fuel on June 2-3, 1964.

Annual rainfall on the watersheds averaged 65.1 inches in 1964, 40.5 in 1965, and 50.5 in 1966. Deviations from the long-term mean were +11.8, −12.8, and −2.8 inches. Thus, after treatment there was a wet year, a dry year, and a year with nearly average rainfall. Rainfall distribution, however, was atypical and runoff from the control for each of the post-treatment years exceeded the pretreatment mean. In 1965, no runoff occurred after March 29. Monthly rainfall and runoff during the

Table 1.—*Average number of trees and basal area per acre*

Watershed No.	Trees[1]			Basal area[1]		
	Growing stock	Cull[2]	Total	Growing stock	Cull[2]	Total
	– – – – – *Number* – – – –			– – – – *Square feet* – – – –		
I	98	84	182	24	21	45
II	108	120	228	25	26	51
III	117	117	234	38	21	59
Mean	108	107	215	29	23	52

1 Includes all stems over 0.5-inch d.b.h.
2 All blackjack oak considered cull.

Figure 1.—*The watersheds were burned with a slow backfire on December 19, 1963.*

study period are given in Appendix tables 8 and 9.

Instrumentation

Three-foot H-flumes equipped with water-stage recorders measure runoff from the watersheds (*6, pp. 22-24*). Deposited sediment is collected in concrete approach sections. Samples for suspended sediment determinations are obtained with a Coshocton wheel sampler (*3*).

The three watersheds are contiguous. A recording rain gage is located near the center of the study area, and six nonrecording gages form a network over the area.

Calibration

The paired watershed approach was taken. Wilm (*7, 8*) presented analytical methods for determining the adequacy of calibration of annual discharge from paired watersheds, and Kovner and Evans (*2*) extended them. Reinhart (*4*) applied these methods to monthly and seasonal yields and to peak and low flows. Runoff from the study watersheds was largely ephemeral, and main reliance was placed on calibration relationships based on individual runoff events. The adequacy of such calibrations has been reported (*5*).

Pretreatment relationships among watersheds were developed for the volumes of stormflow and two measures of their distribution—instantaneous peak discharge and the portion of stormflow volume estimated as overland flow. All events which produced runoff on either the control or a treated watershed were included in the stormflow-volume analyses. A storm was defined as a precipitation event bounded by rainless intervals of at least 6 hours. The calibration and post-treatment equations for the three variables are summarized in Appendix tables 10, 11, and 12.

Analyses

The linear regression model to describe relationships between watersheds during the calibration period is $Y = a + bX$. The calibration regressions were compared by covariance analysis with the regressions developed from data collected during each year after treatment. The null hypothesis is that the two regressions are estimates of the same general equation. If this hypothesis is rejected, the conclusion is that the relation between phenomena on the control watershed (X) and a treated watershed (Y) has changed, and that two equations are required to describe the relations before and after treatment.

Covariance analysis can determine whether the change is some function of X or is best expressed as a constant for all values of X (*1*). The first step is to test for differences in slope. If slopes differ, the magnitude of change varies with X.

When slopes were found to be significantly different, each individual measurement after treatment was subjected to a t-test, and the probability of the magnitude of the change determined. Repeated use of the t-test, comparing successive post-treatment observations against the same prediction equation, fails to meet statistical standards because requirements for independence are not met. However, such comparisons are informative and were made. The t-tests were for increases only. Thus, only one end of the probability curve was considered.

If the slopes of the equations do not differ, differences in level can be tested. Here again, since the critical value for testing equal levels cannot be precisely determined, the hypothesis of equal slopes cannot be tested without some probability of error. However, to aid interpretation where a change in level was indicated, the two equations were adjusted to a common slope and the average change determined. The average change was also expressed as a percentage of the pretreatment mean. All testing was at the 5-percent level of confidence.

Where variances of regressions differed significantly and a change in level was indicated, a conservative test was applied. The largest variance and its degrees of freedom were used in the F tests for differences in slope and level. While true differences in pre- and post-treatment variances might exist, none of the conclusions regarding change in level was altered as a result of this procedure.

Ratios of sediment yields before and after treatment were also compared.

TREATMENT EFFECTS

Runoff

Stormflows, overland flows, and peak discharges increased on both watersheds during the first 3 years after treatment. There was little indication that the increases in each of the runoff variables lessened during this time.

Annual after-treatment regressions are evaluated for each of the three runoff variables in the sections following. The most reliable indicators of change are the regressions developed from data collected during all 3 years after treatment. Without exception, a change in slopes was indicated for the regressions based on 3-year data.

Stormflow volumes. — Twenty-four percent of the events on Watershed II and 27 percent of those on Watershed III during 1964-1966 produced stormflow volumes significantly higher than predicted (table 2).

Watershed II produced 4 area-inches more water than expected (a 30-percent increase), and Watershed III produced 7 more area-inches (a 26-percent increase) during the 3 years. A few key storms produced a large proportion of the increases. In 1964, a 4.3-inch August storm accounted for 70 percent of the annual increase from Watershed II and 38 percent of the annual increase from Watershed III. Similarly in 1966, a 5-inch storm in February produced 70 percent of the annual increase from Watershed II and half the increase from Watershed III. Thus, the treatment applied could contribute substantially to both summer and winter floods.

Overland flow.—Overland flow was defined as the volume of stormflow represented by the part of a hydrograph above a straight line drawn between the beginning of a rise and the point of maximum curvature on the recession.

Estimated overland flows were less sensitive to treatment than stormflows. Fourteen percent of the events on Watershed II and 17 percent of those on Watershed III during 1964-1966 were significantly higher than predicted (table 3). Watershed II produced 22 percent more overland flow during the 3 years (1.89 area-inches) and Watershed III produced 27 percent more (3.89 area-inches). Seventy-one percent of the 3-year increase from Watershed II and 48 percent of that from Watershed III resulted from two storms—August 15, 1964, and February 9, 1966.

Peak discharges.—Analyses were confined to runoff events which produced instantaneous peak flows $\geq$ 0.05 c.f.s. (cubic feet per second) per acre on the control or a treated watershed.

Peak flows were higher than predicted by significant amounts for 23 percent of the runoff events on Watershed II and for 25 percent of those on Watershed III (table 4). The total 3-year increase was 36 percent for Watershed II and 28 percent for Watershed III.

On Watershed II, peak flows were not significantly larger than predicted in 1966. Treatment effect may have been declining, but the regression was based on only seven events.

Table 2.—*Treatment effects on volumes of stormflow*

Year	Change in regression: Slope	Change in regression: Level	Events	Events significantly higher than predicted	Total increase[1]	
			No.	*Pct.*	*Area-inches*	*Pct. of predicted*
			Watershed II			
1964	*	...	29	21	1.21	22
1965	*	...	13	31	1.01	22
1966	*	...	11	27	1.84	54
1964-1966	*	...	53	24	4.06	30
			Watershed III			
1964	*	...	31	19	2.72	22
1965	...	*	14	(2)	1.34	16
1966	*	...	11	54	2.95	46
1964-1966	*	...	56	27	7.01	26

1 Sum of measured minus predicted values.

2 The average difference between the pre- and post-treatment regressions adjusted to a common slope was 0.098 area-inch. This increase was 33 percent of the pretreatment mean.

* Statistically significant at 5-percent level.

Table 3.—*Effect of treatment on volumes of overland flow*

Year	Change in regression: Slope	Change in regression: Level	Events	Events significantly higher than predicted	Total increase[1]	
			No.	*Pct.*	*Area-inches*	*Pct. of predicted*
			Watershed II			
1964	*	...	22	9	0.65	21
1965	*	...	10	20	.32	10
1966	*	11	18	18	.93	38
1964-1966	*	...	43	14	1.89	22
			Watershed III			
1964	*	...	26	12	1.64	28
1965	n.s.	n.s.	10	0	.11	2
1966	*	...	11	45	2.13	54
1964-1966	*	...	47	17	3.89	27

1 Sum of measured minus predicted values.

* Statistically significant at 5-percent level.

Table 4.—*Treatment effects on peak discharges*

Year	Change in regression: Slope	Change in regression: Level	Events	Events significantly higher than predicted	Total increase[1]	
			No.	*Pct.*	*C.f.s./acre*	*Pct. of predicted*
				Watershed II		
1964	*	...	13	38	1.57	53
1965	*	...	10	20	.64	31
1966	n.s.	n.s.	7	0	.23	13
1964-1966	*	...	30	23	2.45	36
				Watershed III		
1964	*	...	18	22	1.38	33
1965	*	...	10	20	.40	15
1966	n.s.	*	8	(2)	.76	34
1964-1966	*	...	36	25	2.54	28

1 Sum of measured minus predicted values.
2 The average difference between the pre- and post-treatment regressions adjusted to a common slope was 0.092 c.f.s. per acre. This increase was 44 percent of the pretreatment mean.
* Statistically significant at 5-percent level.

Sediment

The relationship of annual sediment production among watersheds was fairly consistent during the pretreatment years. The yields from Watershed II were approximately twice those from the control, while the yields from Watershed III approximated those from the control (fig. 2). These ratios were applied to predict yields in the post-treatment years, and the increases were calculated as measured minus predicted values.

Sediment-yield increases the first year averaged 428 pounds per acre (table 5). Yields from Watershed III continued higher than expected during the second and third years. The increase from Watershed II was largely confined to the first year.

Average annual sediment concentrations for Watershed III also increased markedly during the first and second years after burning and hardwood control (fig. 3), but returned to pretreatment levels the third year. Thus, both runoff and the concentrations of sediment per unit of runoff from Watershed III increased as a result of watershed treatment. Data for Watershed II were too variable to demonstrate changes in average concentrations of sediment.

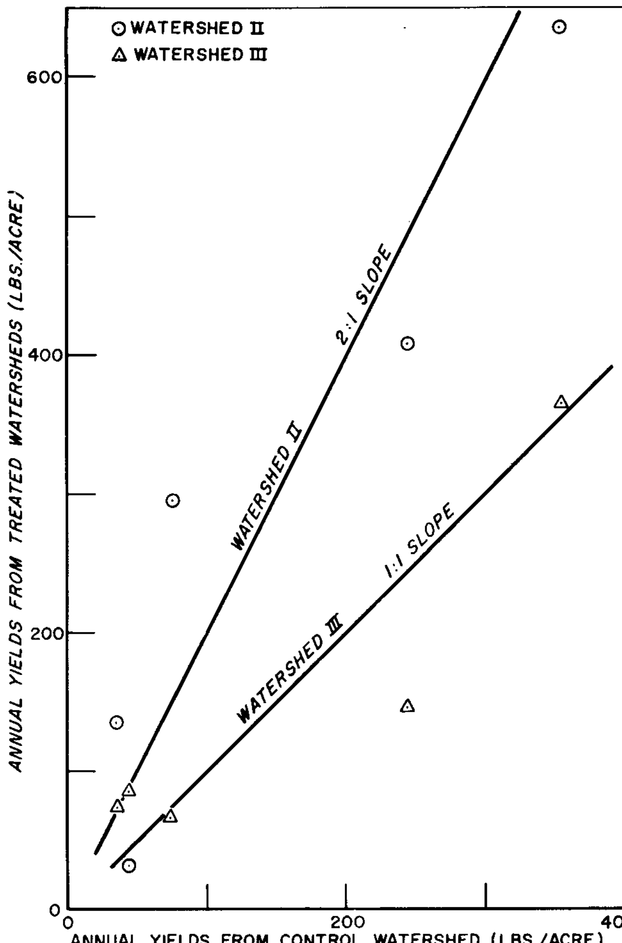

Figure 2.—*Average annual sediment yields during pretreatment years.*

Table 5.—*Sediment yields before and after treatment*

Watershed	Preburn means	Postburn yields			Increase over prediction
		Measured	Expected	Increase	
		Pounds per acre—dry weight			*Percent*
		1964			
I Control	151	397	...	...	...
II	300	1,179	794	385	48
III	148	868	397	471	119
		1965			
I Control		180	...	...	...
II		390	360	30	8
III		408	180	228	127
		1966			
I Control		58	...	...	...
II		84	116	Decrease	...
III		128	58	70	121

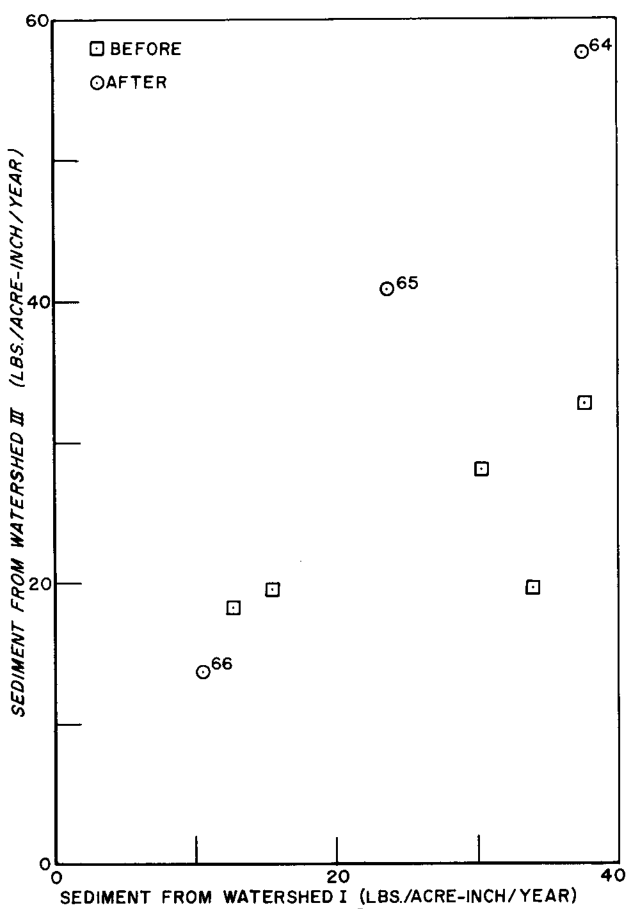

Figure 3.—*Average annual sediment concentrations on control and Watershed III before and after treatment.*

Vegetation

The L (litter) layer on the two treated watersheds prior to the burn weighed an average of 1,500 pounds per acre; the F (fermentation) layer weighed 6,870 pounds per acre (table 6) (fig. 4). The fire consumed the L layer but reduced the weight of the F layer by less than 1 percent (fig. 5). Leaves from the dying hardwoods restored the L layer during the first year after burning, but 60 percent of the F layer disintegrated during this time. Thus, the loss of forest floor material during the first year after burning was greater than during the burn itself.

The total weight of the forest floor 1 year after the burn averaged 55 percent of the preburn weight; after 3 years, it averaged 51 percent of the preburn weight.

Grasses and forbs began to invade the area during the second spring after burning. The ovendry weight of this vegetation, clipped 1 inch above the groundline in December 1965, averaged 1,250 pounds per acre. It increased to an average of 1,885 pounds per acre by October 1966 (fig. 6).

Sprouts and stems less than 1 inch in diameter increased from 150 per acre prior to the burn, to 6,644 per acre 2 years after the burn, and to 11,020 per acre 3 years after burning. The planted loblolly pines are competing successfully with this growth.

Table 6.—*Weight of the forest floor before and after the December 1963 burn*

Watershed	Preburn	February 1964	Postburn December 1964	Postburn December 1965	October 1966
			Pounds per acre—ovendry		
			L(A_{00}) layer		
II	1,416	(1)	1,633	281	(1)
III	1,588	(1)	2,208	748	(1)
Means	1,502	...	1,920	515	...
			F (A_0) layer		
II	6,135	5,928	2,039	4,059	4,111
III	7,605	7,741	3,374	5,279	4,432
Means	6,870	6,834	2,706	4,669	4,271
			L + F layers		
II	7,551	5,928	3,672	4,340	4,111
III	9,193	7,741	5,582	6,028	4,432
Means	8,372	6,834	4,627	5,184	4,271

1 Included with F layer.

Figure 4.—*Forest floor just before burning.*

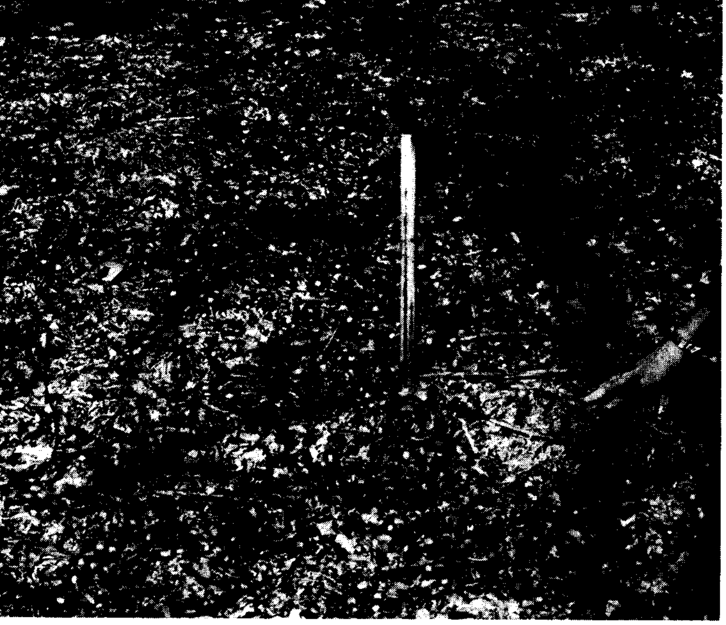

Figure 5.—*The fire removed the L-layer, which consisted largely of the current leaf fall, but it reduced the weight of the F-layer by less than 1 percent.*

Burning exposed mineral soil on 13 percent of the ground surface of the watersheds (table 7). Three years after the fire, 95 percent of the watershed surfaces had some form of cover. Needles cast by the pine should accumulate rapidly during the next few years. Thus, any future effects of treatment may be lessened by the planting of the pine.

SUMMARY

After 6 years of calibration, two small watersheds occupied by depleted hardwood stands were burned in December 1963. A slow backfire consumed the L layer. It reduced the F layer less than 1 percent. The hardwoods were treated with a herbicide in May 1964. A third unburned watershed was maintained as a control.

During the first 3 years after treatment, about one-fourth of the stormflows were increased by significant amounts. Annual increases ranged from 1 to 3 area-inches—increases of 16 to over 50 percent. Estimated overland flows and peak discharges also increased. Two large rains caused a large proportion of the increases. Treatment effects did not diminish during the first 3 years.

Figure 6.—*Three years after the burn the weight of the forest floor averaged one-half the preburn weight. The ovendry weight of grasses and forbs averaged 1,885 pounds per acre.*

Table 7.—*Composition of cover before and after the December 1963 burn and during the recovery period*

Cover class	Watershed	Pre-burn	February 1964	Postburn December 1964	Postburn December 1965	October 1966
		Percent of ground surface occupied				
Grasses, forbs	II	7	2	8	14	12
	III	2	0	4	8	8
Forest floor	II	92	74	74	61	69
	III	95	83	83	80	82
Bare soil	II	0	17	12	15	8
	III	2	11	8	7	2
Moss, lichens, other	II	1	7	6	10	11
	III	1	6	5	5	8

During the first post-treatment year, sediment production from one watershed exceeded the expected value by 48 percent. On the other watershed, it was more than double the predicted value. The increases averaged about 400 pounds per acre. Sediment production continued high from the watershed with loess soils during the second and third years. On the sandy watershed the increase was largely confined to the first year.

The fire removed 18 percent of the organic matter making up the forest floor. Despite the contribution from the dying hardwoods, an additional 26 percent of the preburn weight was lost during the first year. Three years after treatment, the weight of forest floor material averaged one-half the preburn weight.

Sediment increases resulting from the light winter burn of ungullied, poor-quality upland hardwoods and the subsequent deadening of the hardwoods were not alarming. They appeared to be decreasing over the first 3 years and the development of the planted pine should soon practically eliminate soil movement. The increase in runoff, which persisted for 3 years, however, suggests that stand conversion procedures including fire should be used with caution in the hilly uplands of north Mississippi, where flood abatement is an important objective of land management.

LITERATURE CITED

1. Freese, F.
   1964. Linear regression methods for forest research. USDA Forest Serv. Res. Pap. FPL-17, 136 pp. Forest Prod. Lab., Madison, Wis.
2. Kovner, J. L., and Evans, T. C.
   1954. A method for determining the minimum duration of watershed experiments. Amer. Geophys. Union Trans. 35: 608-612.
3. Parsons, D. A.
   1955. Coshocton-type runoff samplers. USDA Agr. Res. Serv. ARS-41-2, 16 pp.
4. Reinhart, K. G.
   1958. Calibration of five small forested watersheds. Amer. Geophys. Union Trans. 39: 933-936.
5. Ursic, S. J., and Popham, T. W.
   1967. Using runoff events to calibrate small forested catchments. Int. Union Forest. Res. Organ. 14th Congr. Proc. 1: 319-324.
6. USDA Agricultural Research Service.
   1962. Field manual for research in agricultural hydrology. USDA Agr. Handbook 224, 215 pp.
7. Wilm, H. G.
   1944. Statistical control of hydrologic data from experimental watersheds. Amer. Geophys. Union Trans. 1943: 618-622.
8. Wilm, H. G.
   1949. How long should experimental watersheds be calibrated? Amer. Geophys. Union Trans. 30: 272-278.

APPENDIX

Table 8.—*Average rainfall by months during study period*[1]

Month	1958	1959	1960	1961	1962	1963	1964	1965	1966
	Inches								
January [2](5.04)	2.64	3.98	5.33	0.76	6.54	1.35	4.22	4.27	2.86
February (4.22)	1.66	4.51	3.68	8.13	7.32	2.50	2.96	8.74	8.55
March (5.71)	4.69	3.07	5.79	12.75	3.67	5.59	9.08	9.04	1.68
April (4.88)	10.52	3.78	2.07	2.65	5.85	6.49	9.91	1.06	7.09
May (4.38)	3.01	3.58	2.64	3.84	1.71	1.97	1.66	2.54	7.01
June (4.34)	8.63	4.92	3.57	1.78	6.82	2.07	1.90	.77	2.83
July (4.26)	5.55	6.33	.44	2.96	3.72	9.77	8.73	1.88	3.24
August (3.61)	2.59	1.90	2.71	3.00	1.78	3.20	6.56	3.67	1.34
September (3.32)	11.21	5.71	3.90	1.74	3.80	3.39	5.13	4.25	5.51
October (2.98)	.73	4.45	4.88	1.51	1.54	0	2.32	.87	2.26
November (4.54)	3.56	3.21	3.19	9.96	2.35	3.77	4.24	1.38	1.68
December (6.02)	1.71	5.61	4.49	10.48	2.20	5.19	8.43	2.03	6.46
Totals (53.30)	56.50	51.06	42.69	59.55	47.30	45.30	65.14	40.51	50.51

1Averages for three watersheds.
2 Long-term means at University, Mississippi, shown in parentheses.

Table 9.—*Runoff by month during study period*

Month	Watershed	1958	1959	1960	1961	1962	1963	1964	1965	1966
		Area-inches								
January	I	0.00	0.61	0.43	0.00	2.21	0.00	0.30	0.70	0.00
	II	.00	.31	.05	.00	.60	.00	.24	.40	.00
	III	.20	1.49	1.00	.00	2.12	.00	.28	1.12	.00
February	I	.00	.98	.33	2.20	2.63	.00	.24	3.42	1.92
	II	.00	.46	.04	1.62	1.94	.00	.06	2.74	2.84
	III	.00	1.32	.67	3.30	2.61	.00	.33	4.56	4.13
March	I	.30	.04	1.89	5.30	.33	.70	3.23	3.46	.07
	II	.00	.01	1.05	3.15	.06	.57	2.08	2.56	.01
	III	.63	.16	2.37	5.83	.52	.75	3.78	4.32	.29
April	I	3.39	.07	.00	.21	1.93	.96	3.17	.00	2.04
	II	1.93	.00	.00	.00	1.25	.61	1.29	.00	1.28
	III	4.27	.19	.00	.31	2.06	1.19	3.43	.00	2.27
May	I	.09	.00	.02	.00	.00	.00	.00	.00	1.14
	II	.01	.00	.00	.00	.00	.00	.00	.00	.72
	III	.04	.00	.03	.00	.00	.00	.00	.00	1.73
June	I	.48	.04	.00	.00	.06	.00	.00	.00	.02
	II	.31	.00	.00	.00	.01	.00	.00	.00	.00
	III	.63	.02	.01	.00	.03	.00	.00	.00	.00
July	I	.01	.01	.00	.00	.00	.00	.02	.00	.00
	II	.00	.00	.00	.00	.00	.00	.01	.00	.00
	III	.01	.02	.00	.00	.00	.00	.07	.00	.00
August	I	.01	.00	.00	.00	.00	.00	.52	.00	.00
	II	.00	.00	.00	.00	.00	.00	1.17	.00	.00
	III	.00	.00	.00	.00	.00	.00	1.63	.00	.00
September	I	1.41	.04	.00	.00	.00	.00	.06	.00	.00
	II	1.40	.01	.00	.00	.00	.00	.15	.00	.00
	III	1.72	.13	.00	.00	.00	.01	.23	.00	.00
October	I	.00	.06	.00	.00	.00	.00	.00	.00	.00
	II	.00	.01	.00	.00	.00	.00	.00	.00	.00
	III	.00	.03	.00	.00	.00	.00	.00	.00	.00
November	I	.01	.00	.00	.47	.00	.00	.08	.00	.00
	II	.00	.00	.00	.40	.00	.00	.04	.00	.00
	III	.00	.00	.00	.34	.00	.00	.76	.00	.00
December	I	.00	.86	.21	3.60	.04	.29	2.99	.00	.38
	II	.00	.47	.01	2.06	.00	.24	2.36	.00	.39
	III	.00	1.13	.11	3.31	.00	.13	4.51	.00	.89
Totals	I	5.70	2.73	2.89	11.80	7.21	1.96	10.62	7.59	5.56
	II	3.65	1.28	1.17	7.23	3.86	1.43	7.42	5.70	5.23
	III	7.50	4.48	4.21	13.09	7.36	2.10	15.02	9.99	9.30

Table 10.–*Calibration and post-treatment regressions relating stormflows on the control (X) and treated (Y) watersheds*

Year	Regression	Number of events	Mean yields	
			$\bar{x}$	$\bar{y}$
			– – – – *Area-inches* – – – –	
	Watershed II			
Prediction equation				
1958-1963	0.66579X – 0.02816	89	0.21737	0.11656
	$Sy.x^2 = 0.00470$, $Sx^2 = 10.93882$, $r = 0.960$			
Post-treatment equations				
1964	0.82370X – 0.03792	29	0.32519	0.22994
1965	.91549X – .09608	13	.58383	.43840
1966	1.07387X – .06755	11	.50579	.47560
1964-1966	.91620X – .05834	53	.42611	.33206
	Watershed III			
Prediction equation				
1958-1963	1.11008X + 0.01602	96	0.25202	0.29578
	$Sy.x^2 = 0.00882$, $Sx^2 = 14.77702$, $r = 0.978$			
Post-treatment equations				
1964	1.26013X + 0.05225	31	0.34251	0.48386
1965	1.19289X + .06710	14	.54213	.71380
1966	1.52514X + .07441	11	.50579	.84581
1964-1966	1.28236X + .06809	56	.42449	.61244

Table 11.—*Calibration and post-treatment regressions relating overland flows on the control (X) and treated (Y) watersheds*

Year	Regression	Number of events	Mean yields	
			$\bar{x}$	$\bar{y}$
			---- *Area-inches* ----	
	Watershed II			
Prediction equation				
1958-1963	0.84871X − 0.01310	86	0.12412	0.09224
	$Sy.x^2 = 0.00373$, $Sx^2 = 3.02547$, $r = 0.935$			
Post-treatment equations				
1964	1.06616X − .02285	22	0.18104	0.17017
1965	1.07818X − .06708	10	.37317	.33526
1966	1.27516X − .04792	11	.27905	.30791
1964-1966	1.12675X − .03878	43	.25079	.24380
	Watershed III			
Prediction equation				
1958-1963	1.16272X + 0.03304	94	0.14297	0.19927
	$Sy.x^2 = 0.01067$, $Sx^2 = 4.13274$, $r = 0.922$			
Post-treatment equations				
1964	1.49535X + 0.04039	26	0.16806	0.29170
1965	1.01594X + .09922	10	.37317	.47834
1966	1.74982X + .06313	11	.27905	.55142
1964-1966	1.44226X + .04940	47	.23768	.39220

Table 12.—*Calibration and post-treatment regressions relating peak discharges on the control (X) and treated (Y) watersheds*

Year	Regression	Number of events	Mean yields	
			$\bar{x}$	$\bar{y}$
			– – – – – *C.f.s./acre* – – – –	
	Watershed II			
Prediction equation				
1958-1963	0.93839X − 0.01793	34	0.21638	0.18512
	$Sy.x^2 = 0.00209$, $Sx^2 = 1.38659$, $r = 0.974$			
Post-treatment equations				
1964	1.42822X − 0.02465	13	0.26078	0.34780
1965	1.40170X − .06425	10	.23874	.27039
1966	.93100X + .01742	7	.29324	.29043
1964-1966	1.27188X − .02336	30	.26101	.30861
	Watershed III			
Prediction equation				
1958-1963	0.86838X + 0.05568	49	0.17757	0.20988
	$Sy.x^2 = 0.00223$, $Sx^2 = 1.89121$, $r = 0.965$			
Post-treatment equations				
1964	1.36681X + 0.03235	18	0.20098	0.30705
1965	1.20898X + .01438	10	.23874	.30301
1966	1.03985X + .10566	8	.25993	.37594
1964-1966	1.24131X + .04248	36	.22457	.32124

Ursic, S. J.

1970. Hydrologic effects of prescribed burning and deadening upland hardwoods in northern Mississippi. South. Forest Exp. Sta., New Orleans, La. 15 pp. (USDA Forest Serv. Res. Pap. SO-54)

A winter burn and deadening of hardwoods with herbicide significantly increased stormflows, overland flows, peak discharges, and sediment production from two small watersheds in northern Mississippi. Most of the hydrologic effects were still evident 3 years after the fire.